11:40 a.m. - 11:50 a.m.

Computer Session 1 (Room S201)

Conceptual Experiments Become "Real" With Virtual Reality

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Research in Physics learning is often based on the analysis of symbolic representations provided by pupils. In effect, much of what physicists know takes the form of images, non-propositional types of knowing, which often appear associated to imaginary situations. There are many examples where physicists used imaginary worlds to build new insights. For example, Einstein said that he approached relativity thinking how the world would be seen by someone riding a photon. Gamow, in his famous books on Mr. Tompkins, wrote about swimming in the middle of water and alcohol molecules. Kekule had a "vision" of the benzene molecule. Faraday has imagined field lines without actually seeing them, etc. Nowadays, computer-based worlds are powerful because they can capitalize on and improve the human capability for imagery. Technologies which are becoming more and more sophisticated allow learners to see physical processes which would be otherwise difficult to visualize and, therefore, to construct better qualitative understandings.

There have been many studies related to understanding and development of concepts of the atomic theory of matter. The results show that some incorrect concepts are promptly transferred from the macro-world to the micro-world. The scientific idea of a substance is a conceptualization, contingent upon a number of other ideas like those of atomes and molecules. The pupils should appreciate that the identity of a substance is independent of the physical state it might appear. Changes of state are only due to a different aggregation of the same atoms or molecules.

To aid pupils understanding of the atomic theory of matter, the Physics and Mathematics Departments of the University of Coimbra, Portugal, the Exploratory Henry the Navigator and the High Education School for Technology and Management of Guarda, are developing the "Virtual Water" project, a virtual environment devoted to the learning of the constitution and properties of water in its different phases. Within this environment, the simulation of the molecular dynamics of the solid, liquid and gaseous phases and phase transitions takes place in three dimensions, with the additional possibility of haptic interaction. We hope that with virtual reality tools like this, conceptual experiments become more and more "real", helping the development of correct mental models. Feedback from pupils is being collected and analysed. If these techniques are successful, teacher's strategies should incorporate them.